Conservation Planning of Crop Wild Relatives in the Republic of Mauritius

Presented by: Navindra Boodia

Senior Lecturer, Faculty of Agriculture, University of Mauritius

List of Contributors: Y. Jaufeerally Fakim, P. Bissessur, S. Kell, I. Thormann, J. Magos Brehm, C. Baider, M. Rughoo, N. Maxted and E. Dulloo

Final Dissemination Workshop

23 November 2016, Pretoria, South Africa

PRESENTATION OUTLINE

1. Background
2. CWR Conservation Planning
3. Checklist Development of CWR
4. Inventory & Annotation
5. Prioritization Process
6. Priority CWRs for Conservation
7. Status of *In-situ* Conservation
8. CWR Utilisation Potential
9. Way-forward: Strategic Actions


Solanum violaceum
Source: M. Rughoo

Crop Wild Relatives

- Crop wild relatives (CWR) are wild plant species that are closely related to cultivated crops. They can be used as gene donors to improve commercial crops.
- CWRs are a critical source of genes for resistance to pests, diseases and stresses such as drought and extreme temperatures.
- They can be used in plant breeding, with the potential to enhance sustainable food security in the face of challenges such as climate change.
- In this presentation, the focus shall be on CWRs native to the RoM.

Why Study CWR in the Republic of Mauritius (RoM)

- Islands are volcanic in origin
- Organisms on them evolved in a relatively isolated environment until human travelers arrived
- Both islands have many endemic species, organisms found nowhere else.
- In MRU, several commercial crops have wild relatives that occur locally, including sugarcane, banana, eggplant, ground nut, pigeon pea, pineapple, potato, and tomato. However, they are not native to Mauritius.
- In Rodrigues, wild relatives of cultivated crops include those of eggplant and pineapple.

Value of CWR: a source of adaptive traits

Crop	CWR	Application(s)
Barley (*Hordeum vulgare*)	*H. spontaneum*	Drought and temperature tolerance
Sweet potato (*Ipomoea batatas*)	*I. trifida*	Root knot nematode and root lesion nematode resistance
Lettuce (*Lactuca sativa*)	*L. serriola*	Downy mildew resistance
	L. virosa	Leaf aphid resistance
Tomato (*Lycopersicon esculentum*)	*L. chmielewskii, L. peruvianum*	Water stress tolerance, drought and salinity tolerance, soluble solids, insect resistance
	L. chilense	Tomato yellow leaf curl virus
	L. chmielewskii	Soluble solids
	L. hirsutum, L. pimpinellifolium	Improved processing ability
	L. pimpinellifolium	Wilt causing fungus
		Quality control characters
	L. pimpinellifolium	Fruit size and shape
	L. pimpinellifolium	Disease resistance, early maturity, determinate growth habit, parthenocarpy, soluble solids
Cassava (*Manihot esculenta*)	*M. aesculifolia*	Robustness
	M. angustiloba	Drought tolerance

$120 billions toward increased crop yields per year

(Maxted and Kell 2009)

CWRs – Why to Conserve them?

CWRs are expected to be affected by climate change

CWRs are threatened by the loss, degradation and fragmentation of their natural habitats and they face fierce competition from alien species.

CWRs are often located in disturbed habitats (e.g. field margins, forest edges and roadsides etc…), that are not being conserved.

Conservation Planning of CWR (I)

National CWR Conservation Plan: Definition

A document that sets out a coordinated, systematic and integrated approach to the *in situ* and *ex situ* conservation of a particular country's CWR diversity (Maxted et al, 2013).

In a nutshell, the CWR Conservation Plan

- establishes CWR conservation objectives;
- evaluates current conservation actions;
- reviews the resources required to implement conservation;
- attributes responsibilities to various organisations; and
- sets the conservation actions in a broader context

Conservation Planning of CWR (II)

National CWR conservation Plan comprises of the following key steps:

- Preparation of a national CWR checklist and inventory
- Prioritization of national CWR
- Conducting different analyses (e.g. eco-geographic; complementarity; gap; threat assessment)
- Formulation of the NSAP

Such a plan is incomplete without provisions for:

- promoting the utilization of CWR; and
- monitoring the conservation status of CWRs

Generation of Checklists

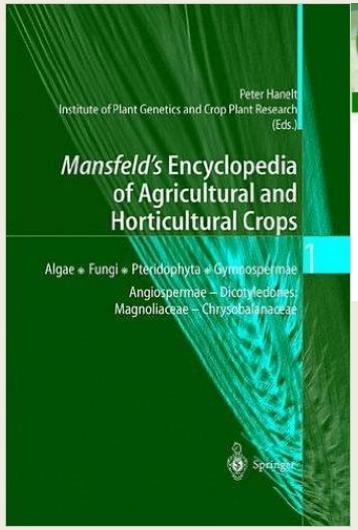
Developed through a process of data harmonization & cross-verification of the national flora with the Mansfield's World Database

Global and local sources

Literature: Publications, books

Online websites

Expert knowledge

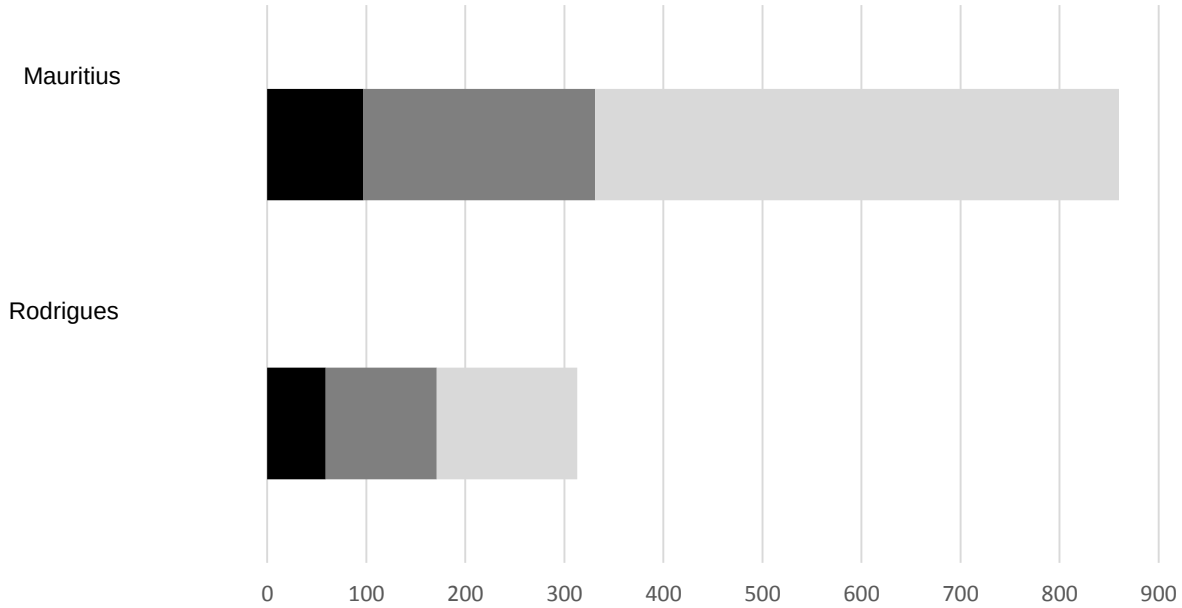


Known uses

Taxa were categorized:

- Food and Agriculture
- Timber
- Medicinal
- Artisanal

Taxonomic diversity in the Checklists (RoM)



	Checklist of Rodrigues	Checklist of Mauritius
Number of family	59	97
Number of genus	112	234
Number of species	142	529

Summary – CWR Checklist (RoM)

	Mauritius		Rodrigues	
Total number	528 taxa (234 genera)		141 taxa (113 genera)	
Endemic	**131**		**28**	
Endemic to Mauritius + Rodrigues	4		4	
Endemic to Mascarenes	79		8	
Native (not endemic)	312		101	
	Genera	**Taxa**	**Genera**	**Taxa**
Agricultural food crop	17	**43**	7	**10**
Forestry	25	74	17	19
Ornamental	31	73	28	32
Medicinal/aromatic	91	**208**	59	**78**
Other	70	128	2	2

Prioritization Process

Prioritization: why it is important?

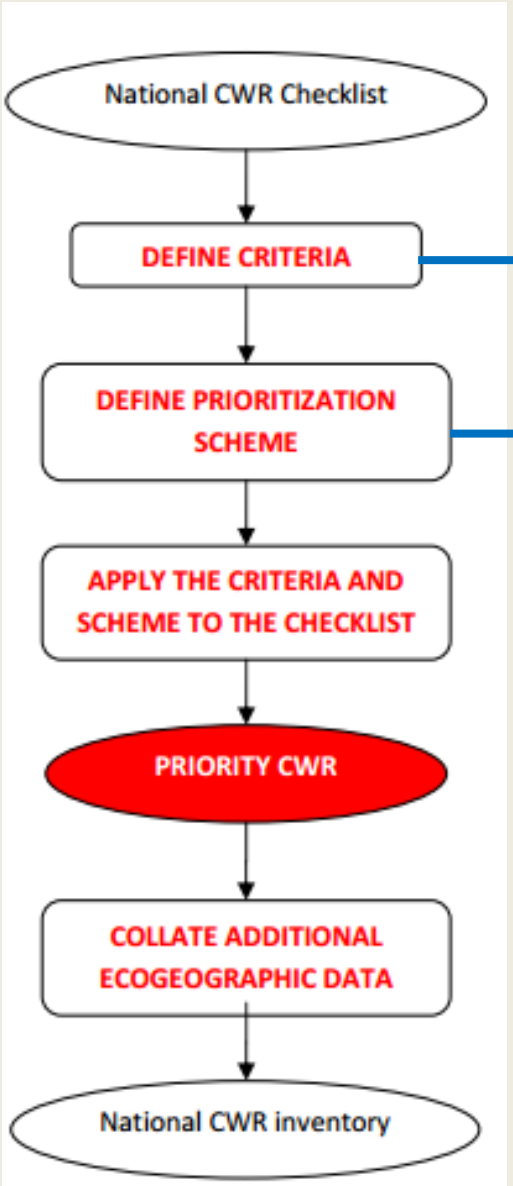
Not all species are equal…

Aloe lomatophylloides

We do value some more than others

Some need special consideration to prevent extinction

Prioritization Process



Selection of the prioritisation criteria – for conservation of the CWR species.

Scoring method – different values were assigned to each criterion

Each species was scored for all the criteria.

The highest scoring species were prioritised for conservation.

Source: Maxted N, Magos Brehm J and Kell S (2013) Resource book for preparation of national conservation plans for crop wild relatives and landraces.

Prioritisation Criteria

Genetic potential as a gene donor	• Primary Gene Pool (GP1); Secondary Gene Pool (GP 2); Tertiary Gene Pool (GP 3); Taxon Group 4 (TG4)
Economic Value of related Crop	• National • Global
Relative distribution	• Endemic, Endemic to Mascarenes,Native,Cryptogenic
IUCN Red List Categories	• CR, EN, VU, NT, DD, NE, LC

Annotation of Checklists

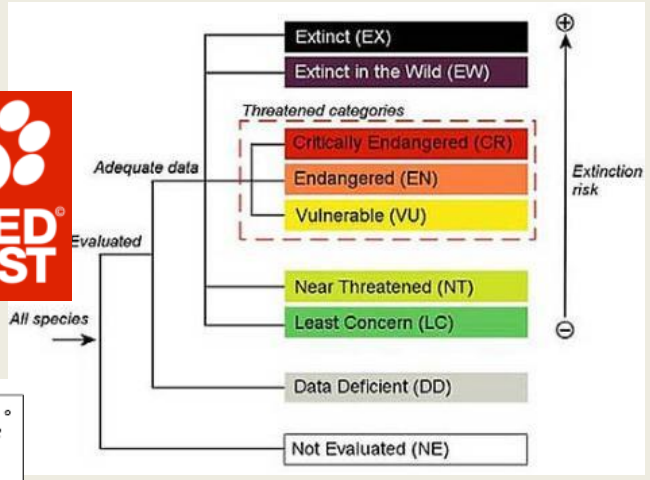
Sources of information

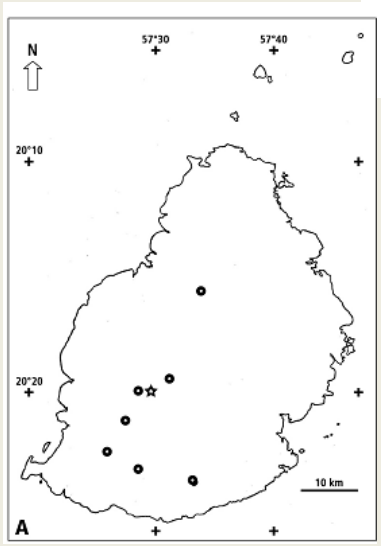
Economic value

Genetic potential

Relative distribution

Conservation status





Mauritius priority CWR

CWR taxon	Related crop	Name of crop	Crop group	Economic value	Utiliation potential for crop improvement	Relative distribution	Red List
Coffea myrtifolia	*C. arabica, C. canephora*	Coffee	Beverage crop	31.70	Tertiary	Endemic to MU	EN
C. macrocarpa					Tertiary	Endemic to MU	VU
C. mauritiana					Tertiary	Endemic to Mascarenes	EN
Olea europaea subsp. *cuspidata*	*O. europaea*	Olive	Oil crop	5.89	Secondary	Endemic to MU	NE
Ficus densifolia	*F. carica*	Fig	Fruits	3.30	TG4	Endemic to Mascarenes	CR
F. laterifolia					TG4	Endemic to Mascarenes	CR
Elaeocarpus bojeri	*E. serratus, E. Floribundus*	Indian olive	Fruits	0.78	Tertiary	Endemic to MU	CR
E. integrifolius					Tertiary	Endemic to MU	CR
Digitaria ciliaris	*D. exilis*	Fonio (millet)	Cereals and pseudo-cereals	158.80	Tertiary	Endemic to MU	DD
D. didactyla					Tertiary	Endemic to MU	DD
Dictyosperma album	For palm heart, locally produced (Mascarenes)			National importance	Primary	Endemic to Mascarenes	CR
Acantophoenix rubra					Primary	Endemic to Mascarenes	CR
Pandanus utilis	Fruits and young branches are consumed on curries, mainly on Reunion				Primary	Endemic to Mascarenes	EW (MU), LC (REU), VU (ROD)

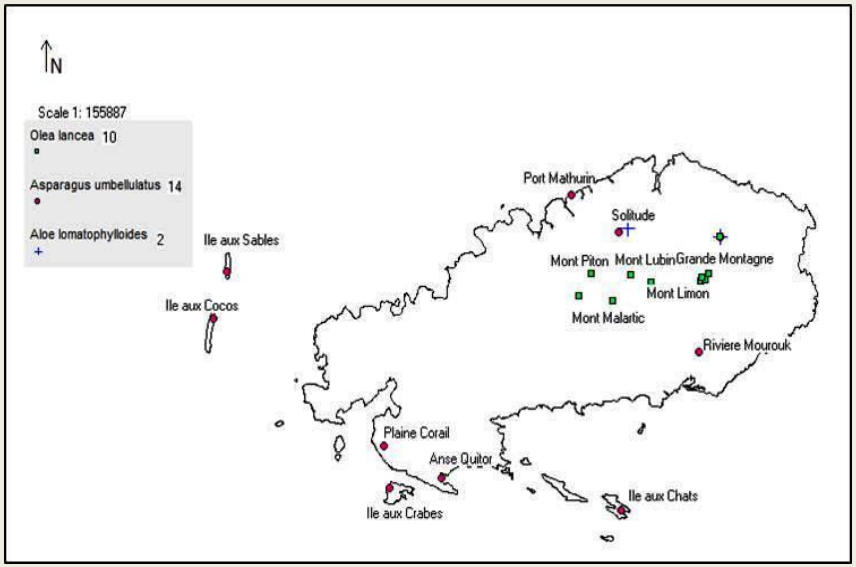
Rodrigues Priority CWR

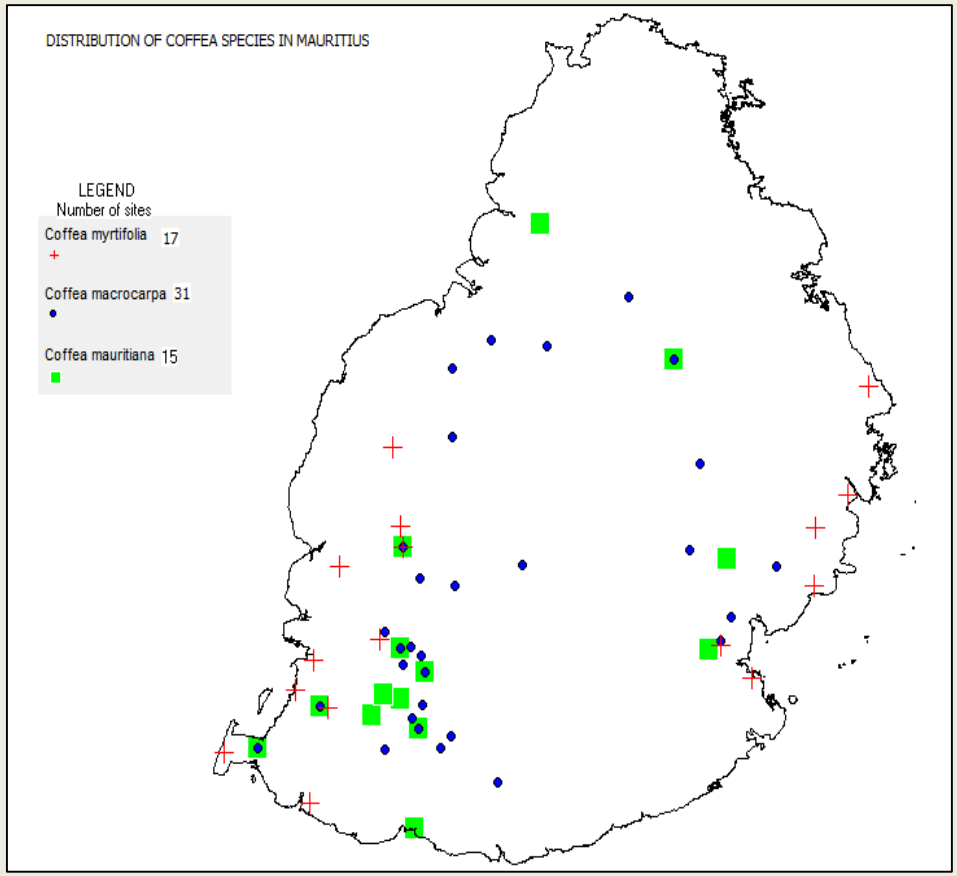
CWR taxon	Related crop	Common name of crop	Crop group	Economic value	Utiliation potential for crop improvement	Relative distribution	Red List
Aloe lomatophylloides	*A. perryi*	Aloe	Succulent and flavors	75.00	TG4	Endemic to MU	EN
Digitaria ciliaris	*D. exilis*	Fonio (millet)	Cereals and pseudo-cereals	158.80	Tertiary	Endemic to MU	DD
D. didactyla					Tertiary	Endemic to MU	LC
Asparagus umbelullatus	*A. officinalis*	Asparagus	Vegetable	1.50	TG4	Endemic to MU	LC
Ipomoea pes-caprae subsp. *Brasiliensis*	*I. batatas*	Sweet potato	Roots and tubers	771.00	TG4	Endemic to MU	LC
Olea lancea	*O. europaea*	Olive	Oil crop	5.89	Tertiary	Native	LC
Panicum brevifolium	*P. miliaceum*	Millet	Cereals and pseudo-cereals	158.80	TG4	Endemic to MU	DD
Ficus reflexa	*F. carica*	Fig	Fruits	3.30	TG4	Native	LC
F. rubra					TG4	Native	LC
Ipomoea violacea	*I. batatas*	Sweet potato	Beverage crop	771.00	TG4	Cryptogenic	NT

Dictyosperma album

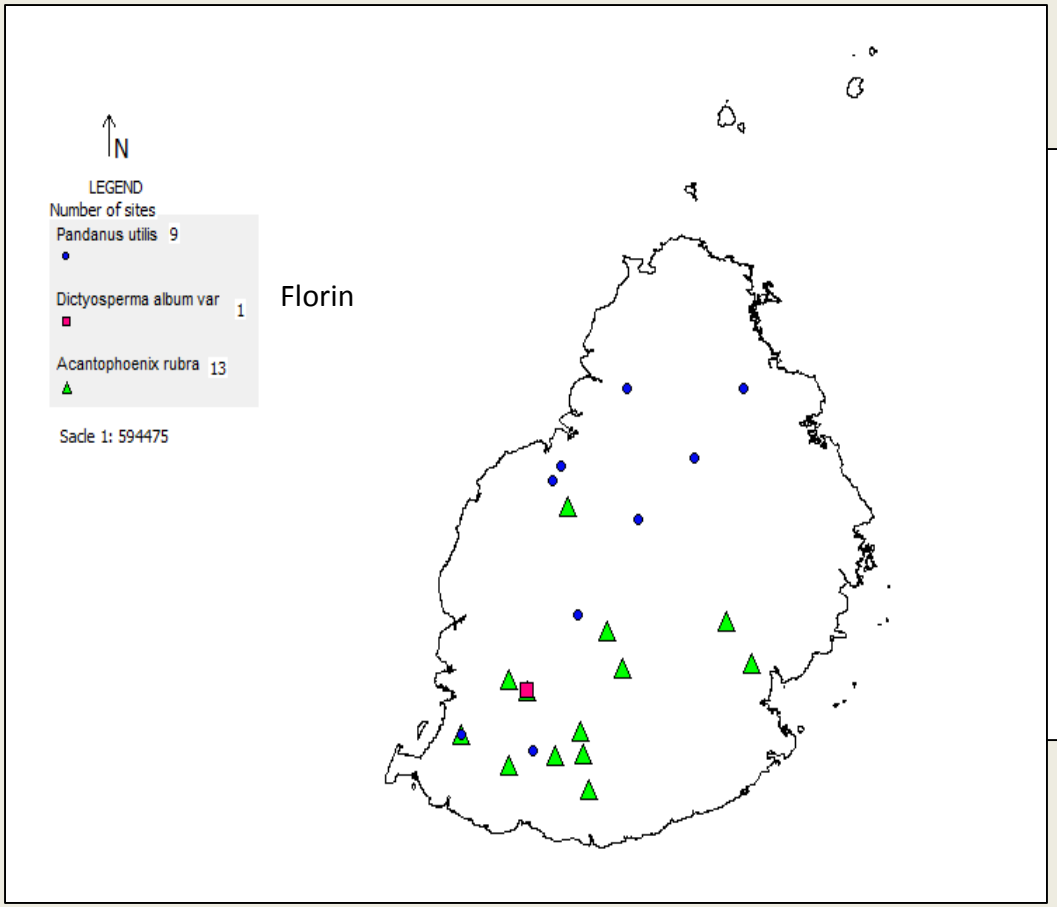
Mauritius and Rodrigues – Collation of Occurrence Data

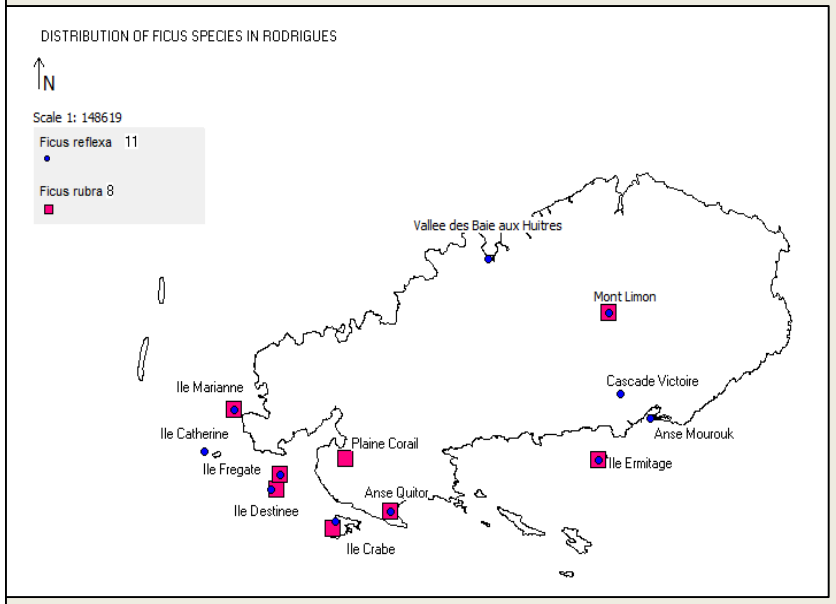
- Collation of occurrence data for priority CWR
- Geo-referenced each location using Google Earth
- Distribution maps – using DIVA-GIS, v. 7.5



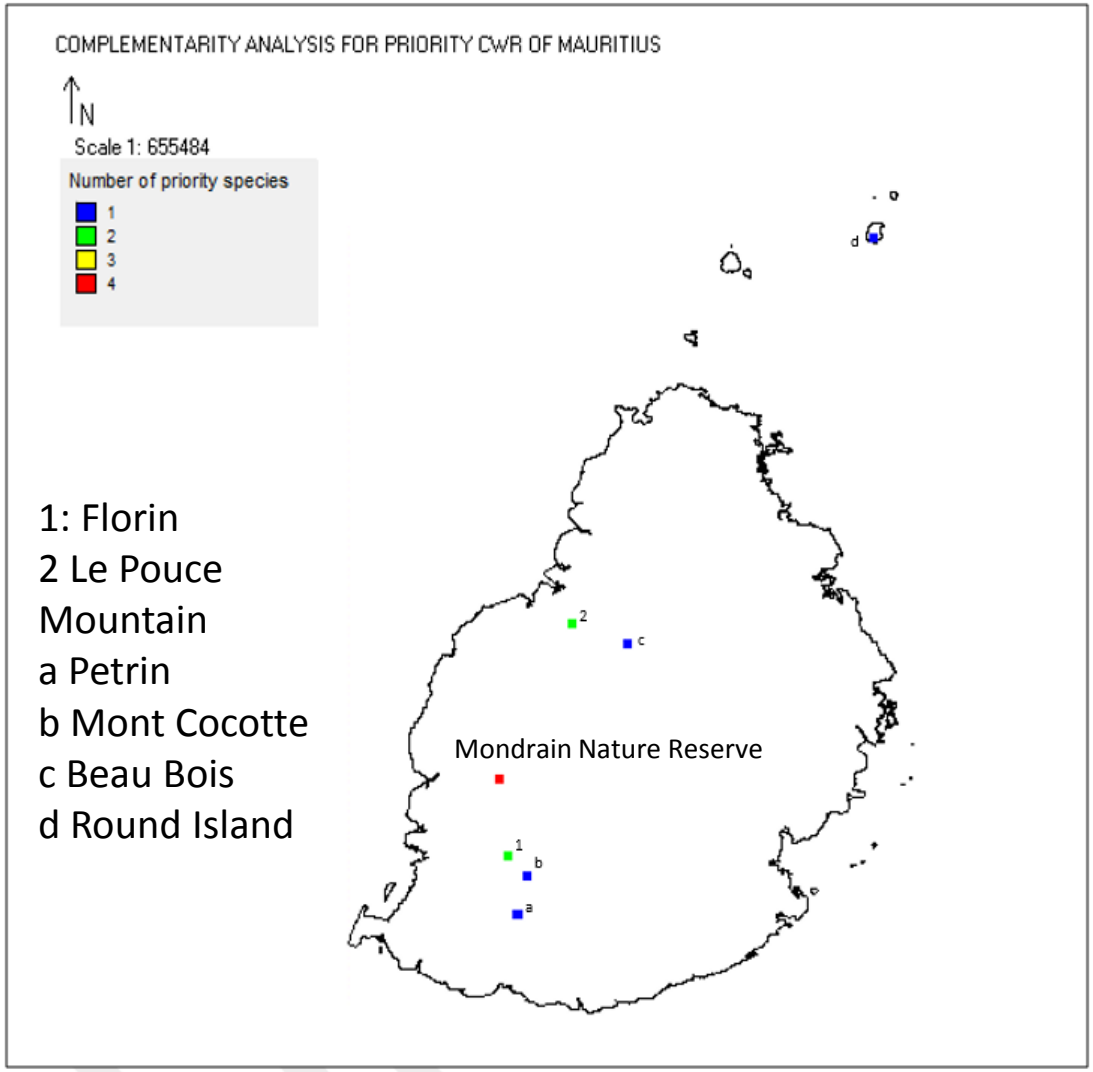


Species Distribtuion Maps





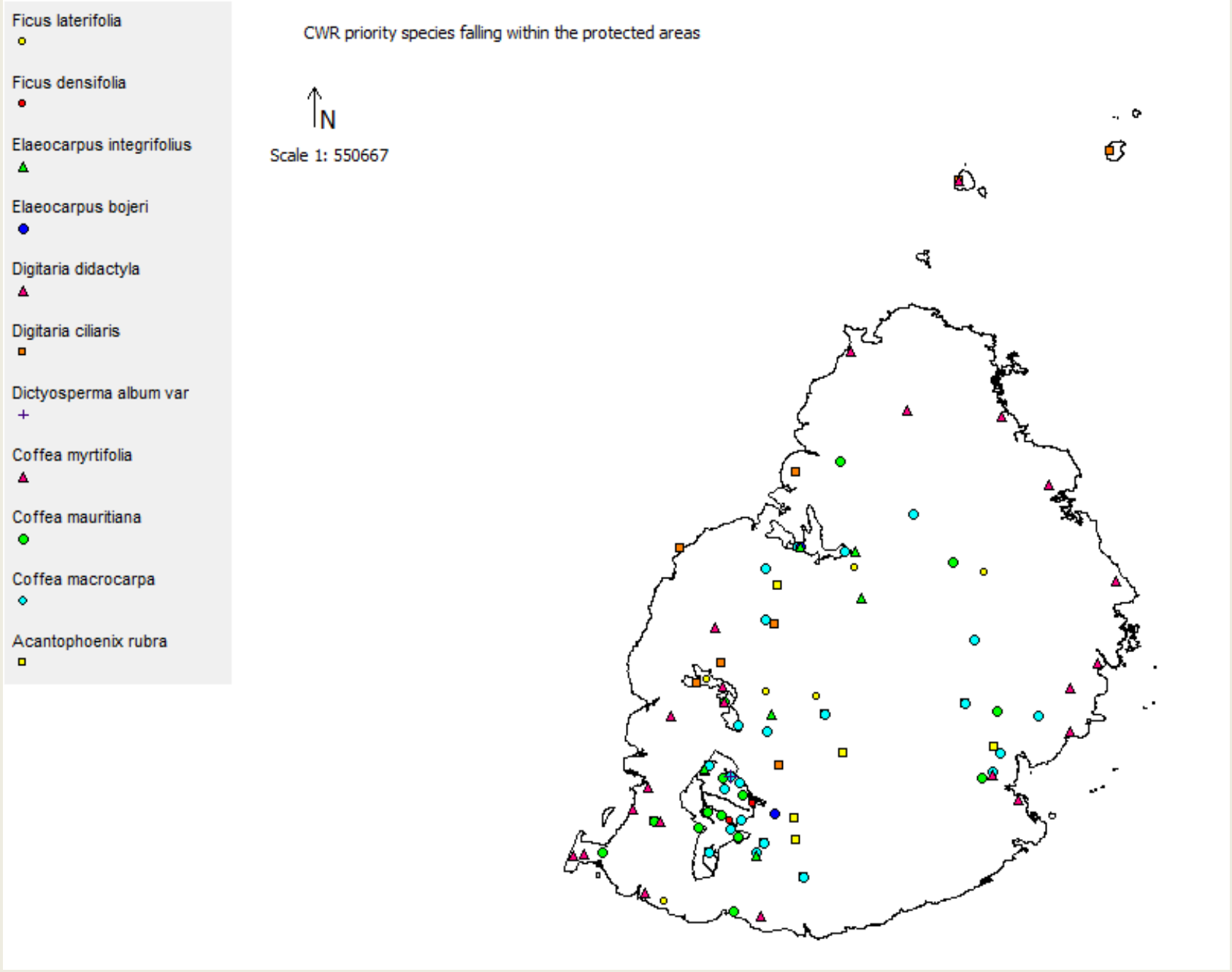
Complementarity Analysis (Mauritius)



- This analysis revealed that 7 locations covered the diversity of the priority CWRs.
- All locations fall under existing Protected Areas (designated national parks, mountain and river reserves and on state lands).
- Mondrain Nature Reserve harbors the highest number of priority CWRs.

Complementarity Analysis (Rodrigues)

Type of protected area	Number of locations	Species	Threat status	Number of populations inside PA	Number of species outside PA
Botanical garden	1	Ficus reflexa	LC	1	0
Nature reserve	5	Aloe lomatophylloides	CR	2	0
		Asparagus umbellulatus	LC	4	0
		Ficus reflexa	LC	3	0
		Ficus rubra	LC	2	0
		Ipomoea violacea	DD	2	0
		Ipomoea pes- caprae	DD	3	0
		Olea lancea	LC	5	0
Private	1	Ficus reflexa	LC	1	0
		Ficus rubra	LC	1	0
Open	13	Aloe lomatophylloides	CR	0	1
		Asparagus umbellulatus	LC	0	9
		Ficus reflexa	LC	0	2
		Ficus rubra	LC	0	2
		Ipomoea violacea	DD	0	1



Map depicting the regions with the highest number of priority CWRs in MRU

Status of *in-situ* Conservation

Priority CWR species	No of locations [1]	Estimated No of Individuals[2]
Coffea macrocarpa	31	8000
Coffea myrtifolia	17	4750
Coffea mauritiana	15	700
Elaeocarpus integrifolius	5	155
Elaeocarpus bojeri	2	13
Ficus densifolia	2	6
Ficus lateriflora	8	8
Acantophoenix rubra	13	375
Dictyosperma album var. album	1	6
Dictyosperma album var. conjugatum	1	1
Olea europaea subsp. cuspidata	4	50
Digitaria ciliaris	8	na[3]
Digitaria didactyla	8	na[3]

Around 118 locations were collated for priority CWRs

[1]Historical data retrieved from the following sources: Flore des Mascareignes, Bosser et al. 1976 onwards; Page and D'Argent, 1997; Dulloo et al., 1999; Kew, 2012; The Mauritius Herbarium database; IUCN Red List, 2015

CWR Utilisation Potential (I)

- **“Conservation of CWR diversity is explicitly linked to utilisation”**
- Utilisation should be "sustainable" and "meet the needs and aspirations of present and future generations” - CBD
- In MRU, research institutions make use of the **introduced** CWR genera: *Solanum*, *Saccharum* and *Lycopersicon spp.* for crop improvement
- None of the native CWR are used currently in pre-breeding/ breeding programmes
- A **selected genotype** of *Dictyosperma album* var. *album* is commercially cultivated for palm heart production
- *Pandanus utilis* might be utilised to some extent

CWR Utilisation Potential (II)

Regarding native CWRs, there are opportunities to be tapped:

- Characterisation and pre-breeding works on *Coffea myrtifolia* (drought-tolerance gene)
- Investigating into the low caffeine content of native Coffea CWRs and to see if they can potentially impart this trait to *C. arabica*
- Characterisation/ genetic analysis of *Dictyosperma spp.* to see if the cultivated species has a larger genetic base than the wild species

Way-forward: Strategic Actions (I)

- **Protect and restore the ecosystems of CWR *in situ* to maintain the existing populations and encourage natural regeneration**
  - Invasive alien species need to be controlled
  - Protected area network needs to expanded to include the CWR hotspots
- **Develop an efficient *ex situ* conservation programme for CWR**
  - Inclusion of priority CWR at ex-situ conservation facilities

Way-forward: Strategic Actions (II)

- **Develop innovative mechanisms for the efficient use of CWR**
  - Research on predictive characterisation
  - Pre-breeding programme to be encouraged in research institutions
  - Involvement of NGOs and local community
- **Establish an efficient system for the dissemination of scientific knowledge with the various stakeholders and awareness of CWR amongst the local population and other Users**

CITED REFERENCES

1. Maxted N, Magos Brehm J and Kell S (2013). Resource book for preparation of national conservation plans for crop wild relatives and landraces.
2. Min of Agro-Industry and Food Security (Unpublished, 2016). National Strategic Action Plan (NSAP) for the conservation and sustainable use of crop wild relatives for the Republic of Mauritius.
3. Technical Background Document (2016).

ACKNOWLEDGEMENTS

Our thanks goes to

- BIOVERSITY INTERNATIONAL
- UNIVERSITY OF BIRMINGHAM
- THE MAURITIUS HERBARIUM
- MAURITIUS SUGARCANE INDUSTRY RESEARCH INSTITUTE
- MINISTRY OF AGRO INDUSTRY AND FOOD SECURITY (MAI&FS)
- NATIONAL PARKS AND CONSERVATION SERVICES
- FORESTRY SERVICES OF MAI&FS
- FOOD AND AGRICULTURAL RESEARCH & EXTENSION INSTITUTE
- UNIVERSITY OF MAURITIUS

CWR TEAM THANKS YOU FOR YOUR ATTENTION